

CLAIMS

What is claimed is:

1. An exhaust aftertreatment combined filter and catalytic converter comprising a plurality of flow channels each having both: a) a flow-through channel catalytically reacting with said exhaust; and b) a wall-flow channel trapping particulate.

2. The exhaust aftertreatment combined filter and catalytic converter according to claim 1 wherein said exhaust aftertreatment combined filter and catalytic converter comprises a plurality of sheets, at least one of which comprises filter media, said sheets defining said plurality of flow channels, including flow-through channels catalytically reacting with said exhaust and including wall-flow channels in the same said flow channels as said flow-through channels and passing exhaust through said filter media sheet and trapping particulate thereat.

3. The exhaust aftertreatment combined filter and catalytic converter according to claim 2 wherein exhaust flows axially through said exhaust aftertreatment combined filter and catalytic converter, and wherein said flow-through channels and said wall-flow channels have axially overlapped channel sections in said flow channels.

4. The exhaust aftertreatment combined filter and catalytic converter according to claim 3 wherein the combination of said flow-through channels and said wall-flow channels have plural catalytically treated surfaces in said flow channels.

5. The exhaust aftertreatment combined filter and catalytic converter according to claim 4 wherein said plural catalytically treated surfaces include said axially overlapped channel sections of said flow-through channels and

said wall-flow channels.

6. The exhaust aftertreatment combined filter and catalytic converter according to claim 4 wherein said surfaces are treated with different catalysts.

7. The exhaust aftertreatment combined filter and catalytic converter according to claim 3 wherein said axially overlapped channel sections have a plurality of surfaces, including a flow-through surface along which exhaust flows, and a wall-flow surface through which exhaust flows, and wherein at least one of said surfaces is catalytically treated.

8. The exhaust aftertreatment combined filter and catalytic converter according to claim 7 wherein both of said surfaces are catalytically treated.

9. The exhaust aftertreatment combined filter and catalytic converter according to claim 3 wherein exhaust flows axially through said exhaust after treatment combined filter and catalytic converter from an upstream end to a downstream end, said filter media sheet has a first face facing upstream and has a second face facing downstream, each said flow-through channel has a portion extending downstream from said second face of said filter media sheet, and wherein said exhaust aftertreatment combined filter and catalytic converter comprises first, second and third serially sequential surfaces in each said flow channel, wherein said exhaust flows firstly along and through said first sequential surface, then secondly along and through said second sequential surface, then thirdly along said third sequential surface, wherein said first face of said filter media sheet is said first sequential surface, said second face of said filter media sheet is said second sequential surface, and said overlapped section of said flow-through channel is said third sequential surface.

10. The exhaust aftertreatment combined filter and catalytic converter according to claim 9 wherein at least one of said first, second and third serially sequential surfaces is catalytically treated.

11. The exhaust aftertreatment combined filter and catalytic converter according to claim 10 wherein each of said first, second and third serially sequential surfaces is catalytically treated.

12. The exhaust aftertreatment combined filter and catalytic converter according to claim 3 wherein exhaust flows axially through said exhaust aftertreatment combined filter and catalytic converter from an upstream end to a downstream end, said filter media sheet has a first face facing upstream and has a second face facing downstream, each said flow-through channel has a portion extending upstream from said first face of said filter media sheet, and wherein said exhaust aftertreatment combined filter and catalytic converter comprises first, second and third serially sequential surfaces in each said flow channel, wherein said exhaust flows firstly along said first sequential surface, then secondly along and through said second sequential surface, then thirdly along and through said third sequential surface, wherein said portion of said flow-through channel is said first sequential surface, said first face of said filter media sheet is said second sequential surface, and said second face of said filter media sheet is said third sequential surface.

13. The exhaust aftertreatment combined filter and catalytic converter according to claim 12 wherein at least one of said first, second and third serially sequential surfaces is catalytically treated.

14. The exhaust aftertreatment combined filter and catalytic converter according to claim 13 wherein each of said first, second and third serially

sequential surfaces is catalytically treated.

15. The exhaust aftertreatment combined filter and catalytic converter according to claim 4 comprising three said catalytically treated surfaces in each said flow channel.

16. The exhaust aftertreatment combined filter and catalytic converter according to claim 15 wherein exhaust flows axially through said exhaust aftertreatment combined filter and catalytic converter from an upstream end to a downstream end, said filter media sheet has a first face facing upstream and has a second face facing downstream, each said flow-through channel has a portion extending downstream from said second face of said filter media sheet, said three catalytically treated surfaces comprise first, second and third serially sequential surfaces, wherein said exhaust flows firstly along and through said first sequential catalytically treated surface, then secondly along and through said second sequential catalytically treated surface, then thirdly along said third sequential catalytically treated surface, and wherein said first face of said filter media sheet is said first sequential catalytically treated surface, said second face of said filter media sheet is said second sequential catalytically treated surface, and said overlapped section of said flow-through channel is said third sequential catalytically treated surface.

17. The exhaust aftertreatment combined filter and catalytic converter according to claim 15 wherein exhaust flows axially through said exhaust aftertreatment combined filter and catalytic converter from an upstream end to a downstream end, said filter media sheet has a first face facing upstream and has a second face facing downstream, each said flow-through channel has a portion extending upstream from said first face of said filter media sheet, said three catalytically treated surfaces comprise first, second and third serially sequential surfaces, wherein said exhaust flows firstly along said first sequential catalytically

10 treated surface, then secondly along and through said second sequential catalytically treated surface, then thirdly along and through said third sequential catalytically treated surface, and wherein said portion of said flow-through channel is said first sequential catalytically treated surface, said first face of said filter media sheet is said second sequential catalytically treated surface, and said second face of said filter media sheet is said third sequential catalytically treated surface.

18. The exhaust aftertreatment combined filter and catalytic converter according to claim 1 wherein said exhaust is diesel engine exhaust.

19. An exhaust aftertreatment combined filter and catalytic converter comprising first, second and third sheets, said first and second sheets defining a plurality of flow-through channels passing said exhaust therethrough and catalytically reacting therewith, said third sheet defining with at least one of said first and second sheets a plurality of wall-flow channels trapping particulate.

20. The exhaust aftertreatment combined filter and catalytic converter according to claim 19 wherein exhaust flows axially through said exhaust aftertreatment combined filter and catalytic converter, and wherein said flow-through channels and said wall-flow channels have axially overlapped channel sections.

21. The exhaust aftertreatment combined filter and catalytic converter according to claim 20 wherein said second sheet is catalytically treated, and said third sheet comprises filter media.

22. The exhaust aftertreatment combined filter and catalytic converter according to claim 21 wherein said first sheet is catalytically treated.

23. The exhaust aftertreatment combined filter and catalytic

converter according to claim 20 wherein exhaust flows axially through said exhaust
aftertreatment combined filter and catalytic converter from an upstream end to a
downstream end, and said third sheet comprises filter media and has a first face facing
5 upstream and has a second opposite face facing downstream.

24. The exhaust aftertreatment combined filter and catalytic
converter according to claim 23 wherein at least one said first and second faces of
said third sheet is catalytically treated.

25. The exhaust aftertreatment combined filter and catalytic
converter according to claim 24 wherein both of said first and second faces of said
third sheet are catalytically treated.

26. The exhaust aftertreatment combined filter and catalytic
converter according to claim 23 wherein said first and second sheets have portions
extending downstream from said third sheet.

27. The exhaust aftertreatment combined filter and catalytic
converter according to claim 26 wherein said downstream portion of at least one of
said first and second sheets is catalytically treated.

28. The exhaust aftertreatment combined filter and catalytic
converter according to claim 27 wherein said downstream portion of said at least one
of said first and second sheets has first and second stages treated with different
catalytic materials.

29. The exhaust aftertreatment combined filter and catalytic
converter according to claim 23 wherein said first and second sheets have portions
extending upstream from said third sheet.

30. The exhaust aftertreatment combined filter and catalytic converter according to claim 29 wherein said upstream portion of at least one of said first and second sheets is catalytically treated.

31. The exhaust aftertreatment combined filter and catalytic converter according to claim 30 wherein said upstream portion of said at least one of said first and second sheets has first and second stages treated with different catalytic materials.

32. The exhaust aftertreatment combined filter and catalytic converter according to claim 19 wherein said exhaust is diesel engine exhaust.

33. An exhaust aftertreatment combined filter and catalytic converter for treating exhaust flowing axially along an axial flow direction along an axis, comprising first, second and third sheets, said second sheet being pleated and forming with said first sheet a plurality of axially extending flow channels, said second sheet having a plurality of pleats defined by wall segments extending in alternating manner between pleat tips at axially extending bend lines, the pleat tips on one side of said second sheet being in contiguous relation with said first sheet, said third sheet having a plurality of pleats defined by wall segments extending in zig-zag manner between pleat tips at transversely extending bend lines which extend transversely to said axis and transversely to said first sheet, said first sheet extending axially and extending laterally relative to said transversely extending bend lines of said pleat tips of said third sheet.

34. The exhaust aftertreatment combined filter and catalytic converter according to claim 33 wherein said axis and said transverse extension of said pleat tips of said third sheet and said lateral extension of said first sheet are all

orthogonal relative to each other.

35. The exhaust aftertreatment combined filter and catalytic converter according to claim 33 wherein said second sheet has spanning segments extending laterally between respective adjacent wall segments of said second sheet such that a respective said flow channel is bounded by distally laterally spaced wall segments of said second sheet defining said flow channel therebetween, and by a respective said spanning segment distally spaced transversely from said first sheet and defining a respective said flow channel therebetween, and wherein said wall segments of said third sheet are nested in said flow channels.

36. The exhaust aftertreatment combined filter and catalytic converter according to claim 35 wherein:

a respective said flow channel is defined by first and second laterally spaced walls segments of said second sheet, and a respective said spanning segment of said second sheet transversely spaced from said first sheet;

said wall segments of said third sheet comprise first and second wall segments having laterally spaced portions in the respective said flow channel and extending axially to a respective said pleat tip, said first wall segment of said third sheet at said pleat tip being laterally spaced from said first wall segment of said second sheet, said second wall segment of said third sheet at said pleat tip being laterally spaced from said second wall segment of said second sheet;

said first and second wall segments of said third sheet, the respective said spanning segment of said second sheet, and said first sheet form a wall-flow channel therebetween such that exhaust passes through said wall segments of said third sheet, trapping particulate thereat;

at least a portion of said flow channel is treated with a catalyst catalytically reacting with said exhaust.

37. The exhaust aftertreatment combined filter and catalytic converter according to claim 36 wherein said wall segments of said third sheet have a first set of edges in contiguous relation with said first sheet, and a second set of distally transversely opposite edges in contiguous relation with said spanning segments of said second sheet.

38. The exhaust aftertreatment combined filter and catalytic converter according to claim 37 wherein:

said first wall segment of said third sheet has a first face laterally facing said second wall segment of said third sheet, and has a second opposite face laterally facing said first wall segment of said second sheet;

said second wall segment of said third sheet has a first face laterally facing said first wall segment of said third sheet, and has a second opposite face laterally facing said second wall segment of said second sheet;

said first wall segment of said second sheet has a face laterally facing said first wall segment of said third sheet;

said second wall segment of said second sheet has a face laterally facing said second wall segment of said third sheet;

at least one of said faces is catalytically treated.

39. The exhaust aftertreatment combined filter and catalytic converter according to claim 38 wherein said second face of said first wall segment of said third sheet and said second face of said second wall segment of said third sheet are catalytically treated.

40. The exhaust aftertreatment combined filter and catalytic converter according to claim 38 wherein said first face of said first wall segment of said third sheet and said first face of said second wall segment of said third sheet are

catalytically treated.

41. The exhaust aftertreatment combined filter and catalytic converter according to claim 38 wherein said second face of said first wall segment of said third sheet and said second face of said second wall segment of said third sheet are catalytically treated, and wherein said first face of said first wall segment of said third sheet and said first face of said second wall segment of said third sheet are catalytically treated.

42. The exhaust aftertreatment combined filter and catalytic converter according to claim 38 wherein said face of said first wall segment of said second sheet and said face of said second wall segment of said second sheet are catalytically treated.

43. The exhaust aftertreatment combined filter and catalytic converter according to claim 38 wherein all of said faces are catalytically treated.

44. The exhaust aftertreatment combined filter and catalytic converter according to claim 36 wherein said first and second wall segments of said third sheet extend axially to a downstream said pleat tip.

45. The exhaust aftertreatment combined filter and catalytic converter according to claim 44 wherein said first and second wall segments of said third sheet converge to a V-shaped apex pointing downstream.

46. The exhaust aftertreatment combined filter and catalytic converter according to claim 36 wherein said wall segments of said third sheet comprise third and fourth laterally spaced wall segments in the same said flow channel as said first and second wall segments of said third sheet, said first and third

5 wall segments of said third sheet extending axially to a second pleat tip in said flow
channel, said second and fourth wall segments of said third sheet extending to a third
pleat tip in said flow channel, said second and third pleat tips of said third sheet being
laterally spaced from each other in said flow channel, said first pleat tip of said third
sheet being axially spaced from said second and third pleat tips of said third sheet,
10 said third wall segment of said third sheet being laterally between said first wall
segment of said second sheet and said first wall segment of said third sheet, said
fourth wall segment of said third sheet being laterally between second wall segment
of said second sheet and said second wall segment of said third sheet.

47. The exhaust aftertreatment combined filter and catalytic
converter according to claim 46 wherein:

5 said first wall segment of said third sheet has a first face laterally facing
said second wall segment of said third sheet, and has a second opposite face laterally
facing said third wall segment of said third sheet;

said second wall segment of said third sheet has a first face laterally
facing said first wall segment of said third sheet, and has a second opposite face
laterally facing said fourth wall segment of said third sheet;

10 said third wall segment of said third sheet has a face laterally facing
said first wall segment of said third sheet;

said fourth wall segment of said third sheet has a face laterally facing
said second wall segment of said third sheet;

at least one of said faces is catalytically treated.

48. The exhaust aftertreatment combined filter and catalytic
converter according to claim 47 wherein said second face of said first wall segment of
said third sheet, said second face of said second wall segment of said third sheet, said
face of said third wall segment of said third sheet, and said face of said fourth wall
5 segment of said third sheet are catalytically treated.

49. The exhaust aftertreatment combined filter and catalytic converter according to claim 47 wherein said first face of said first wall segment of said third sheet and said first face of said second wall segment of said third sheet are catalytically treated.

50. The exhaust aftertreatment combined filter and catalytic converter according to claim 47 wherein said second face of said first wall segment of said third sheet, said second face of said second wall segment of said third sheet, said face of said third wall segment of said third sheet, and said face of said fourth wall segment of said third sheet are catalytically treated, and wherein said first face of said first wall segment of said third sheet and said first face of said second wall segment of said third sheet are catalytically treated.

51. The exhaust aftertreatment combined filter and catalytic converter according to claim 46 wherein said first and second wall segments of said second sheet have portions upstream of said third sheet and catalytically treated.

52. The exhaust aftertreatment combined filter and catalytic converter according to claim 51 wherein said upstream portions of said first and second wall segments of said second sheet have first and second stages treated with different catalytic materials.

53. The exhaust aftertreatment combined filter and catalytic converter according to claim 36 wherein said first and second wall segments of said second sheet have portions downstream of said third sheet and catalytically treated.

54. The exhaust aftertreatment combined filter and catalytic converter according to claim 53 wherein said downstream portions of said first and second wall segments of said second sheet have first and second stages treated with

different catalytic materials.

55. The exhaust aftertreatment combined filter and catalytic converter according to claim 36 wherein said catalytically treated portion of said flow channel is downstream of said wall-flow channel.

56. The exhaust aftertreatment combined filter and catalytic converter according to claim 36 wherein said catalytically treated portion of said flow channel is upstream of said wall-flow channel.

57. The exhaust aftertreatment combined filter and catalytic converter according to claim 35 wherein said second sheet extends axially from an upstream axial end to a downstream axial end, and said third sheet has a first set of said pleat tips at one of said axial ends of said second sheet.

58. The exhaust aftertreatment combined filter and catalytic converter according to claim 57 wherein said first set of pleat tips of said third sheet are at said upstream axial end of said second sheet, and said third sheet has a second set of pleat tips axially spaced downstream from said first set of pleat tips of said third sheet.

59. The exhaust aftertreatment combined filter and catalytic converter according to claim 57 wherein said first set of pleat tips of said third sheet are at said downstream axial end of said second sheet, and said third sheet has a second set of pleat tips axially spaced upstream from said first set of pleat tips of said third sheet.

60. The exhaust aftertreatment combined filter and catalytic converter according to claim 59 wherein said third sheet has a third set of pleat tips

axially spaced from said second set of pleat tips of said third sheet.

61. The exhaust aftertreatment combined filter and catalytic converter according to claim 60 wherein said third set of pleat tips of said third sheet are axially spaced downstream from said second set of pleat tips of said third sheet.

62. The exhaust aftertreatment combined filter and catalytic converter according to claim 59 wherein said third sheet has a third set of pleat tips axially spaced upstream from said first set of pleats tips of said third sheet and axially spaced downstream from said second set of pleat tips of said third sheet.

63. The exhaust aftertreatment combined filter and catalytic converter according to claim 60 wherein said second set of pleat tips of said third sheet has two pleat tips per flow channel.

64. The exhaust aftertreatment combined filter and catalytic converter according to claim 60 wherein said third set of pleat tips of said third sheet has one pleat tip per flow channel.

65. The exhaust aftertreatment combined filter and catalytic converter according to claim 60 wherein said second set of pleat tips of said third sheet has two pleat tips per flow channel, and said third set of pleat tips of said third sheet has one pleat tip per flow channel.

66. The exhaust aftertreatment combined filter and catalytic converter according to claim 33 wherein said exhaust is diesel engine exhaust.

67. A filter for filtering fluid flowing axially along an axial flow direction along an axis, comprising first, second and third sheets, said second sheet

being pleated and forming with said first sheet a plurality of axially extending flow channels, said second sheet having a plurality of pleats defined by wall segments
5 extending in alternating manner between pleat tips at axially extending bend lines, the pleat tips on one side of said second sheet being in contiguous relation with said first sheet, said third sheet having a plurality of pleats defined by wall segments extending in zig-zag manner between pleat tips at transversely extending bend lines which extend transversely to said axis and transversely to said first sheet, said first sheet
10 extending axially and laterally relative to said transversely extending bend lines of said pleat tips of said third sheet.

68. The filter according to claim 67 wherein said axis and said transverse extension of said pleat tips of said third sheet and said lateral extension of said first sheet are all orthogonal relative to each other.

69. The filter according to claim 67 wherein said second sheet has spanning segments extending laterally between respective adjacent wall segments of said second sheet such that a respective said flow channel is bounded by distally laterally spaced wall segments of said second sheet defining said respective flow
5 channel therebetween, and by a respective said spanning segment distally spaced transversely from said first sheet and defining said respective flow channel therebetween, and wherein said wall segments of said third sheet are nested in said respective flow channel.

70. The filter according to claim 69 wherein:

said respective flow channel is defined by first and second laterally spaced wall segments of said second sheet, and a respective said spanning segment of said second sheet transversely spaced from said first sheet;

5 said wall segments of said third sheet comprise first and second wall segments having laterally spaced portions in said respective flow channel and

extending axially to a respective said pleat tip, said first wall segment of said third sheet at said pleat tip being laterally spaced from said first wall segment of said second sheet, said second wall segment of said third sheet at said pleat tip being
10 laterally spaced from said second wall segment of said second sheet;

said first and second wall segments of said third sheet, the respective said spanning segment of said second sheet, and said first sheet forming a wall-flow channel therebetween such that said fluid passes through said wall segments of said third sheet, trapping particulate thereat.

71. The filter according to claim 70 wherein said wall segments of said third sheet have a first set of edges in contiguous relation with said first sheet, and a second set of distally transversely opposite edges in contiguous relation with said spanning segments of said second sheet.

72. The filter according to claim 71 wherein:

said first wall segment of said third sheet has a first face laterally facing said second wall segment of said third sheet, and has a second opposite face laterally facing said first wall segment of said second sheet;

5 said second wall segment of said third sheet has a first face laterally facing said first wall segment of said third sheet, and has a second opposite face laterally facing said second wall segment of said second sheet;

said first wall segment of said second sheet has a face laterally facing said first wall segment of said third sheet;

10 said second wall segment of said second sheet has a face laterally facing said second wall segment of said third sheet.

73. The filter according to claim 70 wherein said first and second wall segments of said third sheet extend axially to a downstream said pleat tip.

74. The filter according to claim 73 wherein said first and second wall segments of said third sheet converge to a V-shaped apex pointing downstream.

75. The filter according to claim 70 wherein said wall segments of said third sheet comprise third and fourth laterally spaced wall segments in the same said flow channel as said first and second wall segments of said third sheet, said first and third wall segments of said third sheet extend axially to a second pleat tip in said flow channel, said second and fourth wall segments of said third sheet extend to a third pleat tip in said flow channel, said second and third pleat tips of said third sheet are laterally spaced from each other in said flow channel, said first pleat of said third sheet is axially spaced from said second and third pleat tips of said third sheet, said third wall segment of said third sheet is laterally between said first wall segment of said second sheet and said first wall segment of said third sheet, said fourth wall segment of said third sheet is laterally between said second wall segment of said second sheet and said second wall segment of said third sheet.

76. The filter according to claim 75 wherein:

said first wall segment of said third sheet has a first face laterally facing said second wall segment of said third sheet, and has a second opposite face laterally facing said third wall segment of said third sheet;

said second wall segment of said third sheet has a first face laterally facing said first wall segment of said third sheet, and has a second opposite face laterally facing said fourth wall segment of said third sheet;

said third wall segment of said third sheet has a face laterally facing said first wall segment of said third sheet;

said fourth wall segment of said third sheet has a face laterally facing said second wall segment of said third sheet.

77. The filter according to claim 69 wherein said second sheet

extends axially from an upstream axial end to a downstream axial end, and said third sheet has a first set of pleat tips at one of said axial ends of said second sheet.

78. The filter according to claim 77 wherein said first set of pleat tips of said third sheet are at said upstream axial end of second sheet, and said third sheet has a second set of pleat tips axially spaced downstream from said first set of pleat tips of said third sheet.

79. The filter according to claim 78 wherein said second set of pleat tips are nested in said flow channels.

80. The filter according to claim 77 wherein said first set of pleat tips of said third sheet are at said downstream axial end of said second sheet, and said third sheet has a second set of pleat tips axially spaced upstream from said first set of pleat tips of said third sheet.

81. The filter according to claim 80 wherein said second set of pleat tips are nested in said flow channels.

82. The filter according to claim 81 wherein said third sheet has a third set of pleat tips axially spaced from said second set of pleat tips of said third sheet.

83. The filter according to claim 82 wherein said second and third sets of pleat tips of said third sheet are nested in said flow channels.

84. The filter according to claim 80 wherein said third sheet has a third set of pleat tips axially spaced downstream from said second set of pleat tips of said third sheet.

85. The filter according to claim 80 wherein said third sheet has a third set of pleat tips axially spaced upstream from said first set of pleat tips of said third sheet and axially spaced downstream from said second set of pleat tips of said third sheet.

86. The filter according to claim 82 wherein said second set of pleat tips of said third sheet has two pleat tips per flow channel.

87. The filter according to claim 82 wherein said third set of pleat tips of said third sheet has one pleat tip per flow channel.

88. The filter according to claim 82 wherein said second set of pleat tips of said third sheet has two pleat tips per flow channel, and said third set of pleat tips of said third sheet has one pleat tip per flow channel.

89. The filter according to claim 67 wherein said fluid is a gas containing particulate to be filtered.

90. The filter according to claim 89 wherein said gas is exhaust from an internal combustion engine.